Capacity Reduction, Quota Trading and Productivity: A Case Study of the Australian South East Trawl Fishery

Kevin J. Fox
University of New South Wales

R. Quentin Grafton
The Australian National University

Tom Kompas
The Australian National University
and
Australian Bureau of Agricultural and Resource Economics

Tuong Nhu Che
Australian Bureau of Agricultural and Resource Economics

Presented at
INTERNATIONAL WORKSHOP ON FISHING VESSEL AND LICENSE BUYBACK PROGRAMS
University of California, La Jolla, March 22-24, 2004

ABSTRACT

This paper analyzes the effects of a license buyback and the establishment of a brokerage service to stimulate quota trading on the profitability of vessels in the Australian South East Trawl Fishery. Using individual firm-level data and a profit index decomposition method, we find that all vessel classes (small and large) experienced substantial productivity gains in the year immediately following the license buyback and the establishment of a quota brokerage service, despite declines in catch per unit of effort for key species in the fishery. Smaller vessels, which may lack the flexibility of large vessels to substitute across inputs, appear to have benefited the most from the changes with their mean contribution of productivity to profits rising by 60 percent over the sample period. The beneficial effects of the buyback and increased quota trading are in stark contrast to the generally unfavourable long-term outcomes commonly associated with vessel buybacks in input-controlled fisheries.

1. Introduction

Many fisheries suffer from excess capacity (Kirkley, Morrison Paul and Squires, 2002) despite the use of input controls and limits on the total number of vessels. The consequences of excess capacity include increased harvesting pressure on fish stocks and an inefficient allocation of resources. A common approach of regulators in input-controlled fisheries is to temporarily address the problem of overcapitalization with a buyback of vessels, gear and/or licenses so as to reduce aggregate fishing effort. Firms often support such approaches provided that the buybacks are voluntary and financed by persons outside of the industry.

Using a unique data set from the South East Trawl Fishery (SETF) of Australia and a recent innovation that decomposes profits into contributions due to productivity, output prices, input prices and (quasi-) fixed inputs, the paper provides an assessment of individual vessel economic performance following a 1997 license buyback and the establishment of a brokerage service to stimulate quota trading. Section 2 of the paper describes the fishery, the details of the buyback program and the effects of the enhanced brokerage service. Section 3 briefly outlines the general method used to analyze firm-level economic performance and section 4 provides an assessment of the impacts of the license buyback and enhanced quota service on economic performance by vessel class. Section 5 concludes.

2. Australia's South East Trawl Fishery, Quota Trades and the Vessel Buyback Program

The SETF is located in Australia's 200 nautical mile exclusive economic zone. It stretches over a very large area of ocean from south of Sydney to encompass all of Australia's oceans off the coasts of Victoria and Tasmania until just beyond the eastern border of South Australia. The fishery is one of Australia's oldest, one of its most regulated, and is managed by the Australian Fisheries Management Authority (AFMA). The fishery's one hundred or so harvesters employ trawls (otter board, Danish seine and mid-water trawl) and harvest over a hundred different types of species. Overall, the SETF accounts for about one fifth of the landed value of commonwealth fisheries, or over AUS$70 million in 1999-2000.

Over the past couple of decades the participants in the fishery have increased their vessel size and capacity. In part, these investments have been made to access deeper water and further offshore fisheries, such as for orange roughy, but they have also occurred as a result of the ‘race to fish’. Due to concerns about overcapitalization, input controls were introduced in 1986 that established vessel unitization whereby every boat was registered in terms of its hull and engine size, defined as boat units. Owners wishing to upgrade their vessels were required to purchase registered units from other operators with an ‘offset’ amount to prevent overall increases in fishing power.

Vessel unitization and input controls failed to prevent an increase in the capital employed in the fishery. To help prevent further increases in capacity, AFMA introduced individual transferable quotas (ITQs) in 1992 that encompassed 16 of the major commercial species in the fishery. The initial allocation of ITQs was contentious as some fishers considered their allocations as insufficient compensation for their loss of previous fishing entitlements associated with their boat units. The introduction of ITQs also failed to bring about the hoped for reduction in the number of vessels operating in the fishery with very low levels of quota traded in the first five years of the ITQ program. Moreover, for all of the ITQ managed species the total allowable catch was non-binding over this period. To address these concerns an industry assisted quota brokerage service was established in 1997 that greatly increased the level of lease quota trading relative to the period 1992-96. As a consequence, average yearly lease quota trades increased by more than 50% to 26,000 tonnes in the period 1997-2000 compared to the preceding 5 years (Kompas and Che, 2003).

Acrimony from the initial allocations, and a concern that ITQs had not delivered the expected benefits to all fishers, led the regulator to also institute a permit or license buyback in 1997. The buyback had a dual purpose: one, to remedy the acrimony over the initial allocation and its associated uncertainty and litigation and, two, to reduce the perceived overcapacity in the fishery allowing for a quicker transition to optimal catch levels. In total, about AUS$4 million was spent in the buyback that included AUS$2.35 million of targeted assistance to 18 fishers designed to avoid further legal action over the initial quota allocation.

The sum of AUS$1.7 million was used to buy back the fishing licenses of 27 fishers (AMC Search Ltd., 2000), with seven fishers receiving both a buyback of their licenses and targeted financial assistance.

The license buyback removed 14 active licenses and 13 dormant or latent licenses from the fishery.[1] Overall, the buyout reduced the number of active fishing vessels from 108 to 94 and vessel capital worth approximately AUS$7 million (AMC Search Ltd., 2000). The buyout was taken up by vessels that were mainly "…small scale with annual turnover of less than AUS$1 million" (AMC Search Ltd., 2000, p. 9). The net effect was to increase the expected profitability in the fishery, as reflected in the boat license to participate in the fishery that rose in value from AUS$60,000 to AUS$85,000 immediately following the license retirement.

3. Profit Decompositions and Productivity

The approach used to decompose relative profits and analyze productivity changes in the SETF is described in detail in Fox, Grafton, Kirkley and Squires, 2003. It employs a Tornqvist (1936) index-number methodology and offers important advantages over traditional measures of productivity in fisheries in that it provides individual firm-level measures and quantifies the contribution of productivity, inputs and outputs to relative profits. The profit decomposition method is applied to the SETF using vessel-level data on the implicit output price, fuel price, price for labor and a capital measure represented by vessel tonnage. The sample data were obtained by the Australian Bureau of Agricultural and Resource Economics (ABARE) and AFMA and are an unbalanced panel of 47 vessels over the period 1997-2000, giving a total of 131 observations. Summary statistics are provided in Table 1.

[1] The removal of latent effort was considered by most in the industry as a satisfactory outcome as it removed the potential for further 'effort explosions' in the SETF (as was the case with the discovery of orange roughy) if any new species or fishing location was discovered (AMC Search, Ltd., 2000).

The (implicit) price for labor is defined as the ratio of total vessel labor payments per vessel over the number of trawling hours and then multiplied by the number of crew. Thus the measure of productivity is not independent of the crew share that is normally paid as a proportion of a vessel's net revenue. Nevertheless, because the crew share is largely identical for all vessels and over time, this has no effect on our measures of productivity trends over the 1997-2000 period. The price of fuel is the recorded price for each of the vessels, and capital is the vessel gross registered tonnage. Variable inputs in the fishery are fuel and labor. We define the restricted profits of an arbitrary firm b, π^b relative to the restricted profits of another firm a, π^a as,

$$\theta^{a,b} \equiv \frac{\pi^b}{\pi^a}. \tag{1}$$

A productivity index between firms b and a, denoted by $R^{a,b}$, is defined as the ratio of an output index and input index between firms a and b, i.e.

$$R^{a,b} \equiv (\theta^{a,b} / P^{a,b}) / K^{a,b} \tag{2}$$

where the numerator is an implicit output index, $P^{a,b}$ is a price index where variable inputs are treated as negative outputs and $K^{a,b}$ is an input quantity index. The decomposition of the profit ratio between vessel a and vessel b, where (b =1,…,120), $\theta^{a,b}$ is thus given by,

$$\theta^{a,b} = R^{a,b} \cdot PO^{a,b} \cdot PL^{a,b} \cdot PF^{a.b} \cdot K^{a,b}. \tag{3}$$

In this profit decomposition the performance of vessel b relative to vessel a can be decomposed into differences due to productivity ($R^{a,b}$), output ($PO^{a,b}$), variable inputs ($PL^{a,b}$ and $PF^{a,b}$) and vessel capital ($K^{a,b}$).[2]

[2]For common-pool resources, an important issue to consider is the effect of the natural capital stock on profits and productivity. Data limitations on the stock assessment of the species in the fishery, however, preclude us from separating out the effects of changes in biomass from other changes over the four years of the sample data. Although this limits our ability to discern what factors may have led to changes in productivity performance, it does not prevent us from analyzing whether fishers experienced productivity gains following the buyback and the establishment of the brokerage service for quota, or the relative contributions of changes in prices and vessel size to relative profits over the period 1997-2000.

Mean profit decompositions are presented in Table 2. The benchmark vessel is the vessel with the highest profits. A value of less than one for the output price index indicates that the contribution of the output price to profit is less than in the benchmark firm. Only four observations in the data set have a PO greater than unity, and most vessels have values considerably less than unity. This suggests that an important factor contributing to the profits of the benchmark vessel was the price it received for its harvest. A value greater than one for the input indexes for all vessels does not imply that the input prices are greater than for the benchmark vessel. Rather, it indicates that the contribution of that input price to the profit ratio is greater than for the benchmark vessel. This could arise if the input price for the given vessel is less than that of the reference firm as an increase in the fuel price reduces profits. If the input price for a given vessel is identical to the benchmark vessel, the corresponding price decomposition index will be unity.

4. Productivity, Quota Trading and the Vessel Buyback

Observation of the mean profit decompositions reveals a number of insights about vessel performance in the fishery. The PO index suggests that the contribution to profits from the implicit output price is higher for larger vessels and that its importance for all vessels rises over time. Part of the reason for this difference across vessel sizes is that larger vessels are able to harvest in deeper waters much further offshore and thus are able to target some very high priced species, such as orange roughy, which cannot be harvested by the smaller inshore vessels. Both vessel classes, however, experienced increases in the contribution to relative profits from rising output process. Table 2 shows that the geometric mean for PO, for all vessels, increased from 0.194 and 0.238 in 1997 and 1998 to 0.379 and 0.371 in 1999 and 2000. No consistent trend is apparent for the variable inputs (PL and PF) across vessel sizes or over time.

If the vessel buyback and increased quota trading combined did have a positive economic benefit to fishers, it should also have raised overall vessel productivity. The evidence from the profit decompositions is that productivity rose over the period 1997-2000, but only for small vessels. However, all vessel classes experienced a productivity jump in 1998 with the productivity contribution to profits rising, respectively by 45% and 29% for small and large vessels.[3] Such gains, in part, occurred because the total allowable catch for all the quota species was non-binding prior to 1997. Thus, despite the existence of individual harvesting rights, the removal of capacity helped to increase the landings of the fishers who remained. This occurred because the 27 licence holders that were bought out from the SETF with the 1997 buyback were obliged to sell their quota-holdings, thereby allowing remaining fishers to optimise their scale of production and raise productivity. Such quota trading is likely to have provided greater benefit to smaller vessels that have less flexibility than larger vessels to substitute between inputs and thereby increase efficiency (Grafton, Squires and Fox, 2000, p. 696).

It would seem, therefore, that a goal of the regulator to raise economic performance has been realized. The extent to which this improvement is attributable to the combined license buyback and industry assisted brokerage services, however, is not immediately clear. The profitability of both small and large vessels improved over the period 1997-2000 due to a rise in output prices, but this was independent of the buyback because the fishery has been managed by ITQs since 1992. A possibility exists, however, that the establishment of limited brokerage services for trading quota in 1997 may have stimulated increases in output prices by allowing fishers to adjust their harvests to better suit market conditions and their catches.

[3] A similar conclusion is obtained in Kompas and Che (2003) where although overall efficiency rises in the SETF with quota trades, large boats (given suspected stock declines on targeted species) are relatively less efficient than small boats over this period.

Such an outcome is supported by the fact that annual lease quota trades increased by over 50% for the period 1997-2000 compared to the period 1992-96.[4]

In sum, the empirical evidence provides support for the hypothesis that the combined license buyback and the establishment of a brokerage service instituted in the fishery in 1997 have had a positive impact on profitability via productivity improvements. Unlike vessel or license buybacks implemented in other fisheries, such as British Columbia's salmon fishery or the US northeast multi-species fisheries (Holland, Gudmundsson and Gates, 1999), it has occurred within a fishery managed by individual and transferable output controls. Thus the SETF offers a unique 'natural experiment' where a buyback, coupled with ITQs, has provided on-going benefits to fishers.

The benefits of the combined buyback and brokerage service do not appear to have diminished over time which might otherwise have been the case if the fishery had been managed by only input controls---a type of fisheries management that can result in both input substitution (Dupont, 1991) and rent dissipation (Dupont, 1990). Indeed, increasing productivity gains for small vessels in 1998, and again in 1999, is suggestive that increased quota trading has helped smaller vessels to better optimize their scale of production and raised productivity. In other words, because the SETF is managed by individual harvesting rights, with an effective quota trading system since 1997, it appears to have avoided the incentive for fishers to increase fishing effort that often follows buybacks (Weninger and McConnell, 2000).[5]

[4]Further support for the buyback and increased quota trading as the causes for the productivity increases is that such gains were simultaneous with a *decline* in catch per unit of effort for seven of the 16 quota species over the period 1997-1998 (AMS Search Ltd., 2000). This indicates that the productivity gains were *not* due to increases in fish stocks. Changes in fish stocks, however, may help explain the subsequent decline in productivity of large vessels since 1998. The large vessels operate primarily in the deep and offshore waters and an important target species, orange roughy, has (it is generally thought) declined in abundance over this period (Bureau of Rural Sciences, 2002).

[5]Weninger and McConnell (2000) show that the net welfare effects of a buyback depends on the opportunity for remaining fishers to replace the removed capacity, the irreversibility of their capital investments and the speed of replacement of fishing capital. Campbell (1989) observes that the net benefits of a buyback varies positively

5. Concluding Remarks

The results indicate a large range in the relative profits and productivities of vessels within the fishery and measurable differences across vessel sizes. In the three years following the buyback and the establishment of an industry assisted brokerage service, all vessels have benefited from a rise in output prices. The results also indicate a substantial increase in mean productivity across all vessel classes immediately following the license buyback and establishment of the brokerage service, despite declines in catch per unit of effort for key species in the fishery. Smaller vessels, which may lack the flexibility of large vessels to substitute across inputs, appear to have benefited the most from the changes with their mean contribution of productivity to profits rising 60 percent from 1997-98 to 1999-2000.

The use of public funds in fishery (industry) adjustment is always controversial, since the permit surrender benefits those remaining in the fishery and could have been potentially industry funded. On the other hand the use of public funds may be rationalized in the SETF on the grounds of redressing problems with the initial quota allocation, and the need to encourage and stimulate trades in ITQs through a more rapid period of structural adjustment.

There is one serious shortcoming from the public assisted buyback scheme in this case however. The purchase of latent licences (although partially limiting future increases in effort in the fishery) appear to have resulted in additional investment in the current fishery, since public funds obtained from the sale of latent licences were evidently invested by operators in the capacity of active vessels. In this sense at least effort in the fishery was not reduced and this practice should be curtailed in the future.

References

AMC Search Ltd. *An Economic Assessment of the South East Fisheries Adjustment Program (SEFAP)*, Draft Report, Canberra, 2000.

---

with the share of the restricted input(s) as a proportion of total costs and inversely with the ability to substitute between restricted and unrestricted inputs.

Bureau of Rural Sciences. *Fishery Status Reports 2000-2001* (Ed. Albert Caton) Agriculture, Fisheries and Forestry--Australia: Canberra, 2002.

Campbell. H.F. "Fishery Buyback Programmes and Economic Welfare" *Australian Journal of Agricultural Economics* 33, no. 1(1989): 20-31.

Dupont, D.P. "Rent Dissipation in Restricted Access Fisheries," *Journal of Environmental Economics and Management*, 19(1990): 26-44.

Dupont, D.P. "Testing for Input Substitutability in a Regulated Fishery," *American Journal of Agricultural Economics* 73(1991): 155-164.

Fox, K.J., R.Q. Grafton, J. Kirkley and D. Squires. "Property Rights in a Fishery: Regulatory Change and Firm Performance," *Journal of Environmental Economics and Management* 46(2003): 156-177.

Grafton, R.Q., D. Squires and K.J. Fox. "Private Property and Economic Efficiency: A Study of a Common-Pool Resource," *Journal of Law and Economics* 43, no. 2(2000): 679-713.

Holland, D., E. Gudmundsson and J. Gates. "Do Fishing Vessel Buyback Programs Work: A survey of the evidence," *Marine Policy* 23, no. 1(1999): 47-69.

Kirkley, J.E., C.J. Morrison Paul and D. Squires. "Capacity, Capacity Utilization in Common-pool Resource Industries," *Environmental and Resource Economics* 22(2002): 71-97.

Kompas, T. and T. N. Che. "Efficiency Gains and Cost Reductions for Individual Transferable Quotas: A Stochastic Cost Frontier for the Australian South East Fishery," *Journal of Productivity Analysis*, forthcoming, 2003.

Tornqvist, L. "The Bank of Finland's Consumption Price Index," *Bank of Finland Monthly Bulletin*, 10(1936): 1-8.

Weninger, Q. and K.E. McConnell. "Buyback Programs in Commercial Fisheries: efficiency versus transfers," *Canadian Journal of Economics*, 33, no. 2(2000): 394-412.

Table 1: Summary Statistics: Data on the South East Trawl Fishery

All Years	***Mean***	***Std. Deviation***	***Min.***	***Max.***
Revenue	485,730	453,259	86,110	2,467,011
Landings	229,164	182,048	22,266	1,171,634
Price	2.13	0.71	1.12	4.47
Crew Hours	3,562	2,391	128	14,095
Labor Price	75	106	15	684
Fuel Quantity	1,175	1,135	64	5,312
Fuel Price	70.00	7.19	63.00	83.00
Vessel Tonnage	82	92	13	670
1997				
Revenue	390,518	378,994	116,996	2,110,863
Landings	215,714	191,165	31,531	1,051,230
Price	1.88	0.69	1.12	4.45
Crew Hours	4,129	2,963	1,276	14,095
Labor Price	42	24	15	129
Fuel Quantity	1,056	1,008	111	4,078
Fuel Price	67.00	0.00	67.00	67.00
Vessel Tonnage	63	48	13	196
1998				
Revenue	426,822	383,243	86,110	2,094,586
Landings	229,111	205,366	38,389	1,171,634
Price	1.91	0.55	1.22	4.47
Crew Hours	3,654	2,404	128	11,829
Labor Price	68	99	19	531
Fuel Quantity	1,065	1,001	107	4,349
Fuel Price	63.00	0.00	63.00	63.00
Vessel Tonnage	73	52	13	196
1999				
Revenue	571,656	526,541	98,993	2,467,011
Landings	241,148	181,019	22,266	889,694
Price	2.39	0.77	1.44	4.45
Crew Hours	3,197	1,965	360	7,245
Labor Price	98	129	16	515
Fuel Quantity	1,329	1,296	98	4,521
Fuel Price	69.00	0.00	69.00	69.00
Vessel Tonnage	94	123	13	670
2000				
Revenue	568,177	510,214	105,770	2,336,295
Landings	231,226	149,968	27,093	615,403
Price	2.38	0.69	1.24	3.90
Crew Hours	3,223	2,073	360	7,038
Labor Price	95	132	20	684
Fuel Quantity	1,274	1,260	64	5,312
Fuel Price	83.00	0.00	83.00	83.00
Vessel Tonnage	94	124	13	662

Notes: There are 30 observations for 1997, 33 for 1998, 29 for 1999, and 28 for 2000. Landings are in the total volume of fish sold, in kilograms; Price is the average price for a kilogram of fish landed; Crew hours is the average number of crew times the number of trawling hour; Fuel Quantity is litres of fuel dispensed; Fuel Price is the average diesel price for Melbourne; Vessel Tonnage is gross vessel tonnage (GVT).

Table 2 Decomposition of Profit Ratios (θ), Means

Obs	*No.*	*Profit*	θ	*R*	*PO*	*PF*	*PL*	*K*
All Years	120	234,625	0.099	0.278	0.281	1.038	3.828	0.318
Small	73	121,619	0.068	0.299	0.260	1.042	4.172	0.201
Large	47	401,174	0.182	0.217	0.304	1.063	4.006	0.648
1997	30	173,551	0.073	0.207	0.194	1.046	5.728	0.303
Small	19	88,535	0.049	0.197	0.182	1.039	6.503	0.203
Large	11	320,398	0.145	0.227	0.218	1.058	4.601	0.602
1998	33	203,622	0.089	0.288	0.238	1.061	3.995	0.306
Small	20	99,080	0.056	0.285	0.223	1.052	4.298	0.195
Large	13	364,457	0.181	0.293	0.265	1.073	3.568	0.608
1999	29	286,361	0.126	0.319	0.379	1.042	2.968	0.337
Small	17	161,388	0.092	0.429	0.364	1.031	2.806	0.204
Large	12	293,173	0.196	0.209	0.402	1.057	3.213	0.686
2000	28	283,015	0.120	0.317	0.371	1.000	3.076	0.331
Small	17	153,218	0.083	0.408	0.345	1.000	2.913	0.202
Large	11	483,611	0.211	0.214	0.415	1.000	3.346	0.709

Note: The arithmetic mean is used to average over the profit values, while the geometric mean is used to average over the indexes. Vessel tonnage (*K*) is used to split up observations into "small" and "large" vessels. Small vessels are defined as those being lighter than the sample average (K<0.318), and large vessels are defined as those being heavier than the sample average (K>0.318). "No." denotes the number of vessels in each year/size category.